MTO Composite CAD

Organization(s): **Carnegie Mellon University; MIT; U. of Pennsylvania; U.C. Berkeley; and Microcosm**

Title: Foundations for Microelectromechanical System Synthesis

Duration of Effort: October 1997 - October 1999

Principal Investigator(s): Gary K. Fedder
Phone: (412) 268-8443 / Email: fedder@ece.cmu.edu
Web: http://www.ece.cmu.edu/~mems/memsyn

Objective

This project aims to shorten the design cycle for MEMS from years to days, and to enable design of more complex MEMS than can be handled today by developing a hierarchical design methodology and associated evaluation and synthesis tools.

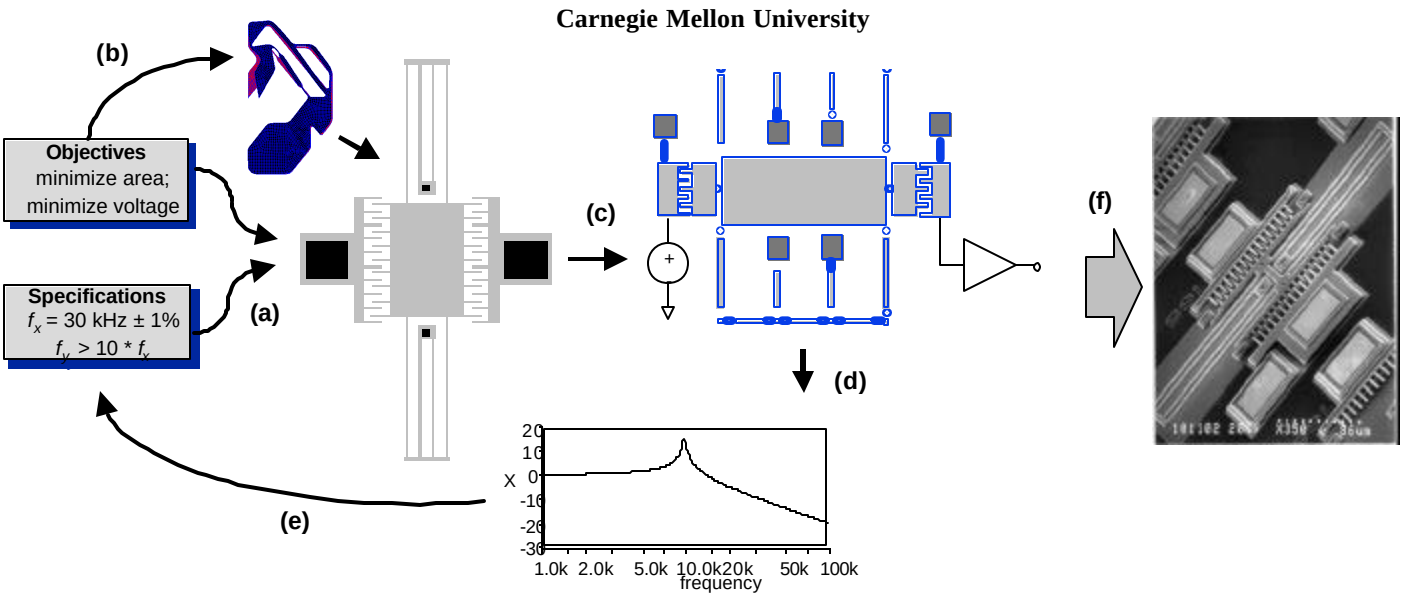
Progress/Results

- Implemented a MEMS schematic representation in Saber and Spectre (NODAS) and in MATLAB (SUGAR) using in-plane models of beams, plates, gaps, combs, and anchors
- Released synthesis modules for comb-drive microresonators and for lateral microaccelerometers (polysilicon and CMOS-MEMS) with cross-axis sensitivity constraints
- Implemented an optimization-based shape synthesis module with force-deflection constraints which has created a 3x displacement amplifier for accelerometers
- Implemented a multilevel Newton nonlinear FE/BE electromechanics solver that allows efficient rigidification of user specified regions
- Completed a Java version for the Semiconductor Process Representation (SPR) populated with the MUMPs process and statistics
- Implemented MEMS shape grammar for structural (topology) synthesis of resonators

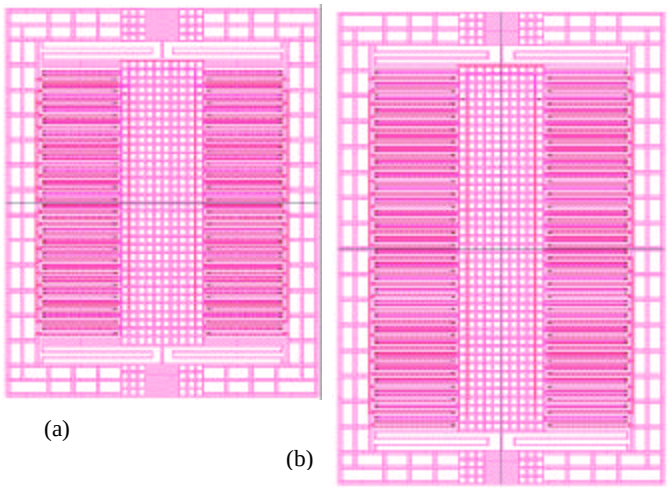
Status

- Validating the MEMS schematic representation and component libraries
- Verifying the CMOS-MEMS accelerometer synthesis module
- Developing mode shape optimization formulations and nonlinear spring synthesis
- Integrating search, control and evaluation aspects of structural (topology) synthesis into an agent-based system

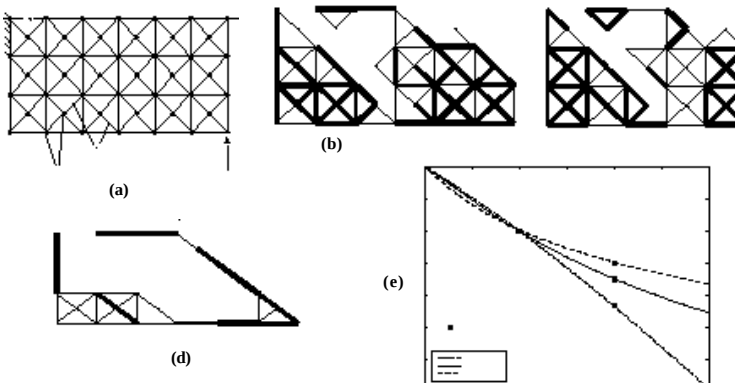
---



Semi-automated design flow for suspended MEMS. (a) Shape synthesis of components. (b) Layout synthesis from user



Synthesized CMOS-MEMS accelerometer layout (a) optimized for minimum area (325 X 425 μm^2) (b) optimized for minimum noise (325 X 500 μm^2)



Design Specifications for the Compliant Crimper Example Two-Point Synthesis of a Compliant Crimper (b) Optimal topology for design case I (c) Optimal topology for design case II (d) Optimal topology for design case III (e) Comparison of the force-deflection characteristics